USE OF A PLASMA JET FOR OBSERVATION OF DESORPTION OF IONS FROM A METAL SURFACE

V. I. Batkin and O. Ya. Savchenko

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Experiments have been described in which desorption of ions has been observed from the surface of a metal placed in a plasma jet, in which the ion energy was close to 30 eV [1-3]. The ions of the plasma jet are easily separated from the ions emitted by the metal, which facilitates observation of desorption.

The schematic of the experimental apparatus is shown in Fig. 1. The arc ion source *1* throws out the plasma jet onto the tantalum target *2* and the grid diode *3*, which forms an ion beam from ions incident on the upper grid of the diode. The plane of the grid diode is oriented along the jet. For such an arrangement of the diode, less than 1% of the ion flux of the jet is extracted from the plasma jet. A small intergrid distance of 4 mm for a diode aperture of 50 mm guarantees the absence of a transverse component of the field accelerating the ions. Therefore a narrow ribbon ion beam of thickness 0.5 mm, formed by the slit *4*, drifts in the direction of motion of the plasma jet only at the velocity which the ions had in the plasma jet. They pass through the collimator *5* into the detector *6* or into the detector of the mass spectrometer *7* only when the voltage on the slit eliminates this transverse velocity.

In Fig. 2, the dashed line shows the dependence of the current I in the detector *6* on the voltage on the slit U in the case when the ion beam is formed from the ions of a hydrogen plasma jet. The voltage on the diode is 5 kV. The voltage on the tantalum target relative to the upper grid of the diode is zero, and the target does not emit ions. As we see from the figure, with an increase in the voltage on the slit, the current in the detector increases and reaches a maximum at a voltage of 105 V, which eliminates the transverse velocity of the ions. A different pattern is observed when a sufficiently high voltage is applied to the tantalum target. The tantalum target (a metallic strip of length 15 mm and width 2 mm) is located at a distance of 20 mm from the upper grid of the diode. In Fig. 2, the solid line is the dependence of the current in the detector on the slit voltage, when a voltage of +70 V relative to the upper grid is supplied to the target and the target emits ions. This dependence has not one, but two maxima. The first maximum, located close to zero voltage, is connected mainly with ions escaping from the tantalum surface, which (in contrast to ions of the plasma jet) do not have a transverse velocity in the beam. The same two maxima are given (for a positive potential of the target) by other plasma jets.

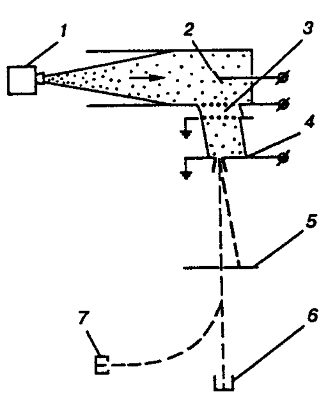

Fig. 1

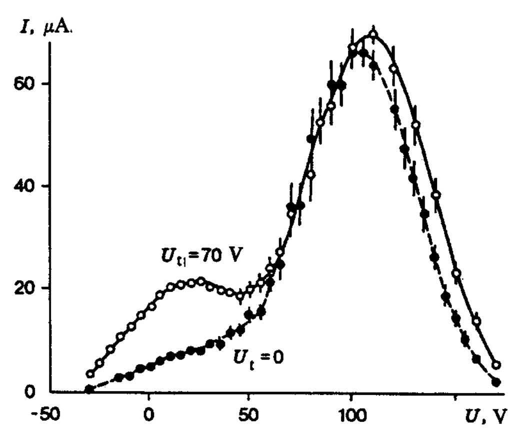

Fig. 2

Institute of Chemical Kinetics and Combustion, Siberian Branch, Russian Academy of Sciences, Novosibirsk 630090.
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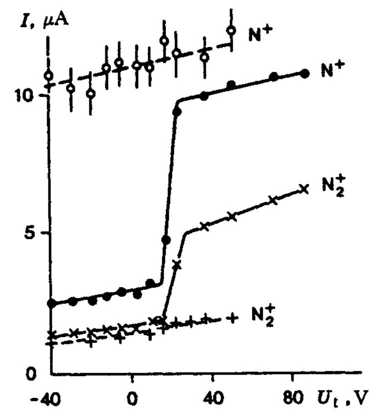

Fig. 3

In Fig. 3, we present the results of mass spectrometric measurements in the case of a nitrogen plasma jet for a voltage on the diode of 2 kV, where the solid lines are the dependences of the fluxes of N^+ and N_2+ ions in the detector *7* on the voltage on the tantalum target U_t at the first current maximum (U = 5 V), and the dashed lines are the dependences at the second current maximum (U = 65 V). At the first current maximum, the fluxes of the N^+ and N_2^+ ions abruptly increase starting from the voltage U_t = 15 V. This is connected with escape of these ions from the tantalum target when the potential of the target is higher than the potential of the plasma, close to 15 V. The weak dependence of the ion current from the target on its potential for potentials above 25 V means that desorption of ions is determined not by the electron or ion bombardment, but rather by photoionization (by plasma radiation) of neutral particles adsorbed by the target. At a temperature above 600°C, these particles are vaporized from the surface, and the ion current from the metal stops.

The experiments presented illustrate the possibility of using plasma jets for studying the interaction of particles from a metal surface. The time resolution of such investigations is limited by the minimum modulation time of the plasma jet, and can reach several tens of nanoseconds [3].

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